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XIV. The effect of change of temperature on the Villari Critical Point of Iron

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remains below it until about 4 A.M., from which hour it is above the Kew curve until it crosses it at about 7 P.M. The minimum ordinate for each curve for each year occurs at about 8 A.M., and the maximum at 1 P.M. The declination has its mean value between 10 A.M. and 11 A.M., and again at between 6 P.M. and 7 P.M. Precisely the same features are to be noticed in the tables given by Mr. Whipple for the years 1870, 1871, and 1872 (Rep. Brit. Assoc. 1886, p. 74); so that it may fairly be assumed that the general nature of the difference between the Greenwich and Kew mean curves from 1870 to 1887 is the same.

The general similarity of the differences is shown clearly by the accompanying curves—the abscissæ of which represent hours, while the ordinates give the mean differences between the Greenwich and Kew readings at these hours. The first set are plotted from the data given in Mr. Whipple's paper. The second set are from the data which we have obtained for the years 1883, 1886, and 1887. The lowest represents the mean of the six curves.

The individual readings do not differ from the corresponding mean to an extent greater than 0'·4. It would therefore seem possible, knowing one set of values for any particular year—Greenwich or Kew—to determine the other set, correct to within four tenths of a minute. As the Kew results are published earlier than the Greenwich ones, it would be possible to calculate approximately the latter from the former.

XIV. *The Effect of Change of Temperature on the* Villari *Critical Point of Iron**. *By* HERBERT TOMLINSON, *F.R.S.*†

[Plates III. & IV.]

THIS paper must be regarded as a continuation of one previously communicated to the Physical Society ‡ on the Villari Critical Points of Nickel and Iron. As before, only the temporary magnetization was studied, and the mode of conducting the observations was also the same with the addition that the effect of loading was tested not only at the temperature of the room but also at various temperatures extending to 285° C. The temperature was ascertained from the resistance of a coil of platinum wire wound double and embracing the same part of the iron wire as the secondary

* The author expresses his thanks to the Elizabeth Thompson Science Fund for aid in this research.

† Communicated by the Physical Society: read June 6, 1890.

‡ Phil Mag. [5] xxix. p. 394.

coil; the temperature-coefficients of the platinum coil had previously been very carefully determined*. The iron wire used was 1 millim. in diameter; it had been thoroughly annealed, and the loads employed were not sufficient, even at the highest temperature, to produce any very sensible permanent extension. As a preliminary the wire was heated to 300° C., tested with all the loads and magnetizing forces to be presently mentioned, and again tested when cooled to the temperature of the room. This treatment was repeated several times until constant results were obtained at both temperatures; the observations recorded in figs. I.–VI. were then made. In these figures the abscissæ represent the number of kilogrammes in the load and the ordinates the percentage alteration of permeability at the temperature indicated on each curve, + signifying increase and − decrease of permeability. The Villari critical point is the value of the magnetizing force for which loading does not affect the permeability and may be ascertained by noting the point at which each curve cuts the line of loads; it varies with the value of the load and with the temperature. In some instances the curves cut the line of loads *twice*, and there are consequently *two* loads which for the magnetizing forces pertaining to the curves have no effect on the temporary magnetization. In the following table is given the load (or loads if there are two) which for each particular magnetizing force and temperature is without effect on the permeability.

TABLE I.

Magnetizing force in C.G.S. units.	Load for which the permeability is the same as for the unloaded wire. Temp. 12° C.	Ditto. Temp. 76° C.	Ditto. Temp. 167° C.	Ditto. Temp. 244° C.	Ditto. Temp. 285° C.
2·84	4·6	4·8	5·1 and 12·0	5·8 and 10·1	
3·70	2·5	3·2	3·6	4·2 and 11·5	4·7 and 9·9
4·83	1·8	2·5	2·7	not tested.	3·1 and 12·3

* For further information concerning the platinum coil and the primary and secondary coils, see Phil. Mag. [5] xxv. p. 372.

It will be seen from Table I. and from figs. I.–IV. that the magnetizing forces 2·84, 3·70, 4·83, and of course all intermediate forces, are Villari critical values. If we regard only the *first point* where each curve cuts the line of loads, we see that at all temperatures the Villari value *increases* as the load *decreases* and, for a given load, increases with the temperature. If, on the contrary, we consider the *second point* of cutting the line of load, we find the critical value *increases both with the load and with the temperature**.

It will be seen from fig. I. that as the temperature rises the two points of cutting the load-line creep nearer and nearer together until for a temperature a little below 285° C. they coincide, and the curve osculates the load-line; whilst for 285° C. and for higher temperatures the magnetizing force 2·84 ceases to be a Villari point for any load. When the magnetizing force reaches the value 7·69 (fig. IV.) both points of cutting the load-line vanish, at any rate when the loading is not carried beyond 12 kilos†, and for magnetizing forces beyond 7·69 (figs. V.–VI.) Villari critical values become impossible.

In all cases rise of temperature increases the alteration of the permeability in the positive direction and diminishes it in the negative direction; but the diminution in the latter case is greater than the increment in the former, so that the summits of the two bends in the curves become more and more nearly on the same level.

The percentage alteration of permeability was calculated as follows:—

If P_0 and P_n represent the permeability with no load and a load of n kilogrammes respectively, the percentage alteration is

$$\frac{100\,(P_n-P_0)}{P_0} \text{ or } \frac{100\,(P_0-P_n)}{P_0},$$

according as the loading produces increase or decrease of permeability. Table II. gives the values of P_0 for the various magnetizing forces.

* The effect of change of temperature on the critical value is therefore in the same direction for both points of cutting the line of loads, *i. e.* in both cases the Villari value is increased by rise of temperature.

† The second point could, however, be probably reached by taking the load to higher values.

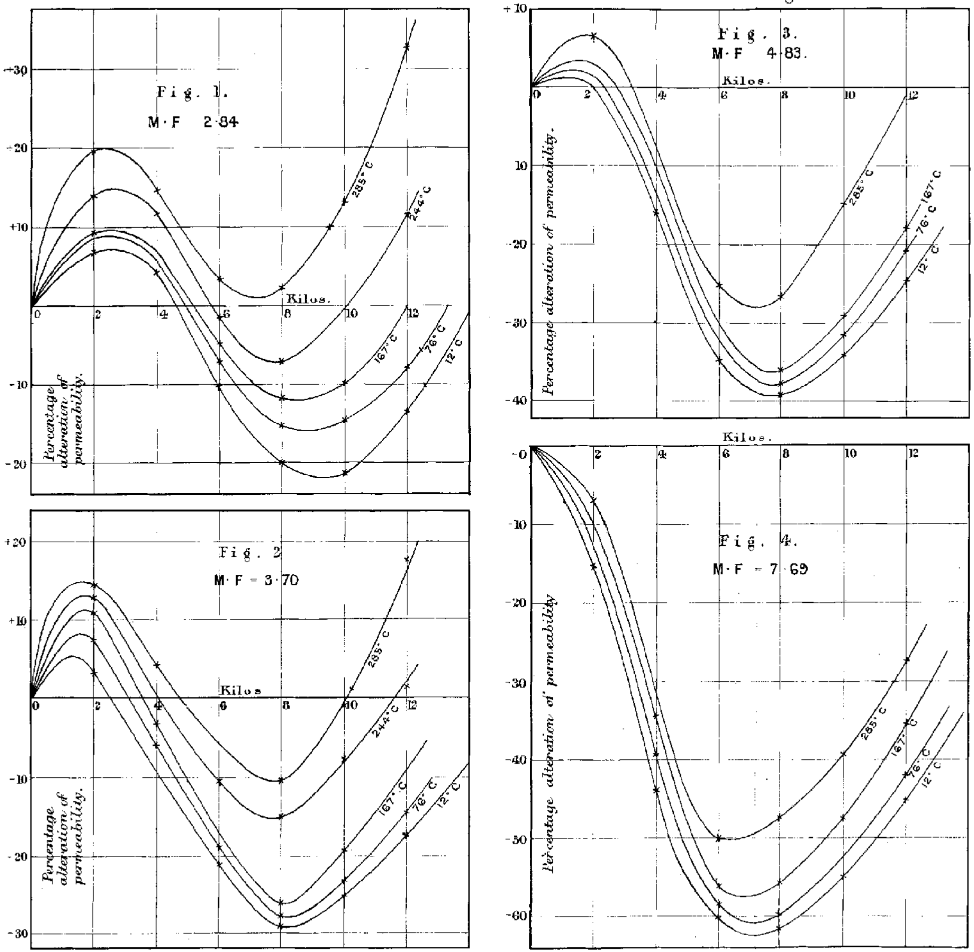
TABLE II.

Magnetizing force in C.G.S. units.	Temporary permeability in C.G.S. units of the unloaded wire at 12° C.	Ditto at 76° C.	Ditto at 167° C.	Ditto at 244° C.	Ditto at 285° C.
2·84	301	306	338	353	385
3·70	325	340	383	385	405
4·83	347	366	413	......	461
7·69	478	483	548	......	557
10·40	528	573	638	......	675
15·32	522	......	......	......	617

XV. *Electrification of Air by Water-Jet.* *By* MAGNUS MACLEAN, *M.A., F.R.S.E., and* MAKITA GOTO (*Japan*)*.

SIR WILLIAM THOMSON, experimenting in the rooms of the Old College, Glasgow, found that electrified air could pass through narrow passages, and he suggested to us to try whether electrified air can pass through a metal tube from one room to another. For this purpose a small room adjoining the Natural Philosophy Class-room of Glasgow University was used. In this room a Thomson quadrant electrometer, whose sensibility was 95 divisions of the scale, per 1 volt difference of potential, and a spirit-lamp supported on an insulating stand and connected to the electrometer, were fitted up. Through the handle-hole of the door separating the small room from the class-room, a metal tube 60 centim. long and 1 centim. in diameter and connected to a gas-pipe by a wire was passed. In the fireplace of the small room a small fire was kept burning to produce draught from the class-room to this room. The class-room was electrified by a spirit-lamp connected to one of the conductors of a large 24-plates electrical machine of Wimshurst type. By this arrangement we could observe any variation of electrification in the small room due to the passage of electricity from the class-room to it. We believe electrified air passed through the tube, but the effect was masked by the draughts

* Communicated by the Authors.



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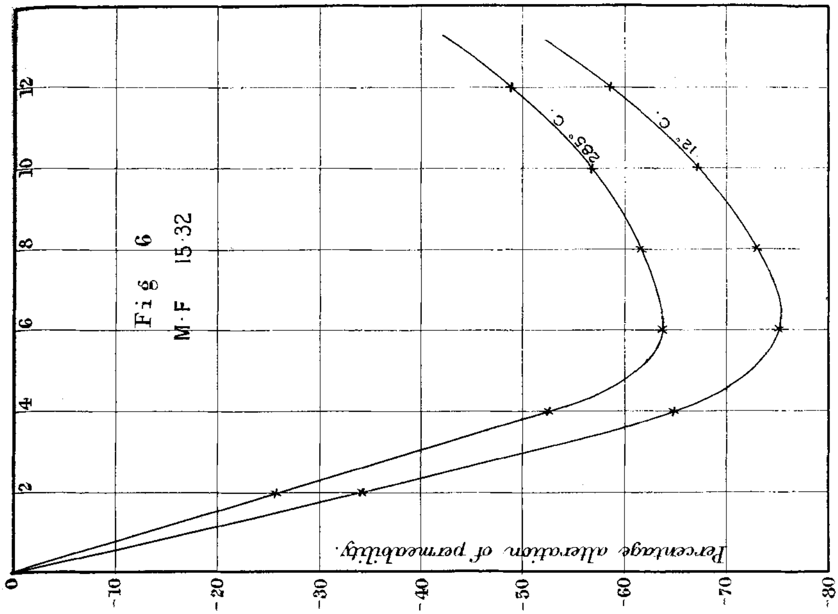

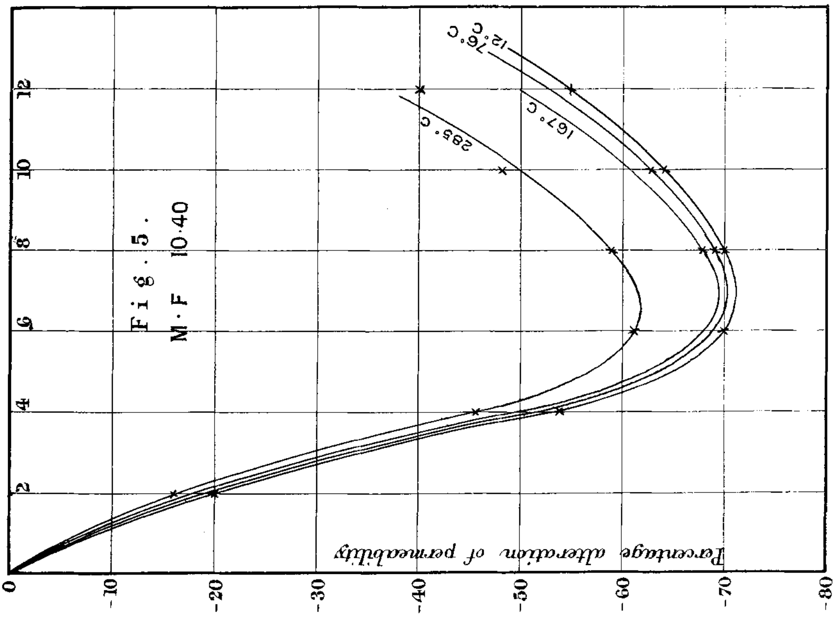

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